§10. Study of Parallel Connected DC Active Filter

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To the power supply driving superconducting magnets in fusion test facility, the low output ripple voltage is required for reduction of noise induced in quench detector. Recently, a series connected active filter is studied to compensate the ripple of thyristor rectifier, but it is difficult to apply this type filter for fusion magnet. Because these power supplies have 20kA class output rating current and all of dc output current of power supply through the active filter or dc decoupling transformer. Therefore, capacity of filter converter or transformer becomes too large compared with compensated volt-ampere. The parallel connected dc active filter gives a solution of ripple reduction, for the large current dc power system.

Fig. 1 shows a conceptual diagram of presented dc active filter connected to a main thyristor rectifier in parallel. In this figure, a current source IGBT PWM converter sinks ripple component i_r of output current of thyristor rectifier through a filter reactor L_{f1}. As a result, this reactor generates counter ripple voltage $L_{f1}\frac{di_r}{dt}$ and it cleans dc voltage supplied to superconducting magnets.

This parallel type active filter has following merit compared with the series type filter when it is applied to a low voltage and large current rectifier.

1. Capacity of active filter becomes very small compared with the main rectifier.
2. Capacitance of passive filter can be reduced and response of power supply becomes well.
3. Controllability in small output current becomes well because dc current flowing into the filter keeps the minimum current of thyristor operation.

For this filter, the ratio of filter capacity Q_f and rectifier capacity Q_r becomes as follows,

$$\frac{Q_f}{Q_r} = \frac{0.034}{\omega L_{f1}} \frac{V_p}{I_{on}}$$

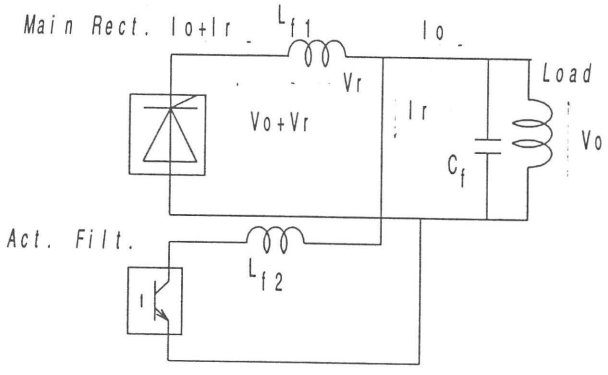

Fig. 1. Conceptual Diagram of Parallel type Active DC Filter.

Tab. 1. Ratings of Active Filter and Rectifier for OV Coil

	Main Rectifier	Active Filter
Output Voltage	33 V	33 V
Output Current	31.3 kA	320 A
Capacity	1.03 MVA	10.6 kVA
Q_f/Q_r	-	1.03%
Series Reactor	9.5 μH	36 μH
Type	12 Phase Rect.	PWM Conv.

where I_{on} is rating output current of rectifier, V_p is peak voltage of rectifier and L_{f1} is filter inductance.

The specifications for an active filter for a dc power supply for OV coil in second plasma phase of LHD is show in table 1. As shown in the table, the necessary capacity of active filter is about 1% of main rectifier.

The results of numerical simulation shows that the ripple current generated by rectifier is compensated by an active filter and output voltage ripple suppressed to 1/10 of original circuit. And the ripple voltage and current generated by PWM operation of active filter are absolved enough by passive filter with L_{f2} and C.